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ESTIMATION THEORY BASIC TO NAVIGATION AND GUIDANCE SYSTEM DESIG--ETC(U)
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FINAL REPORT

Grant AFOSR-71-2141

September 15, 1975 - September 14, 1976

Richard S. Bucy
Principal Investigator

Personnel Supported

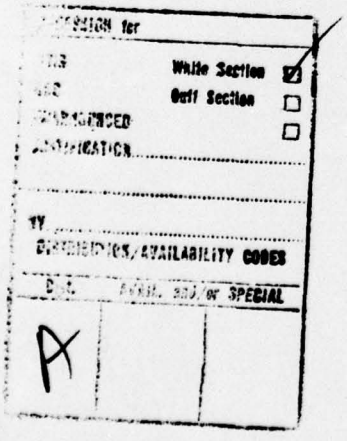
Professor B. A. Troesch of the Department of Aerospace Engineering was supported one month of summer 1976 for software program development. The Principal Investigator was supported for two months in the summer. Graduate assistant, Humberto Torres was supported 75% time for two weeks in September. Administrative secretarial support was provided by Ms. L. Harper and Mrs. V. Wright, while technical typing was supplied by Mrs. I. Allott. Computer support was provided through TRW, Incorporated and Hobbs Associates for time share, while batch processing was provided on 7600 by CDC. Further, a silent 733 was leased from I.C.E. to enable computer support to be used at Eglin Air Force Base, which was telephonic remote computation.

Research Summary

The research program consisted of two parts, parallel and pipeline synthesis of nonlinear filters and a priori bounds for the mean square error of nonlinear filters. The nonlinear filtering problem can be decomposed in two parts, representation and computational realization. In the past, we have extensively investigated the representation problem. We have considered representing the conditional density of signal given the observations via Fourier series, splines, Gauss Hermite expansions and point mass methods. Very early in the program we found that the choice of computational realization device could produce dramatic changes in estimate production speed, especially parallel and pipeline devices. This year we gained access to the Illiac IV, the CDC Star 100, and CDC 7600 and developed programs specially tailored to each machine

to realize the nonlinear filter and take full advantage of the problem's parallel structure for each machine. We increased the speed of estimate production by a factor of 140, of which a factor of 5 was due to being able to write a serial 6600 version of the CDC Star program (which was faster than our original 6600 program). In other words, writing good pipeline code taught us how to write better serial code. Further, the optimal three state dimensional phase amplitude demodulator was realized on Star and estimate time determined. Monte Carlo investigation of this problem is planned for the future.

The second area concerned finding performance bounds on the error variance of the nonlinear filter for a specific problem, the cubic sensor. Any nonlinear filtering problem usually requires costly Monte Carlo simulation to determine the error performance. Lower bounds which are quite good are available in the literature, for example rate distortion bounds. However, upper bounds have been poor in general. Using sensor orbit estimators and nonlinear functions of such estimates, rather effective bounds were discovered. The methods developed for the particular problem have been generalized to be applicable to a general class of problems. The general theory is being developed now.



Papers (9/15/75-9/14/76)

L. Basanez, P. Brunet, R. S. Bucy, R. Huber, D. Miller, J. Pages, "A Hybrid Computer Optimal Filter," Proc. 6th Symposium on Nonlinear Estimation and Applic., Sept. 1975, San Diego.

L. Basanez, P. Brunet, R. S. Bucy, R. Huber, D. S. Miller, J. Pages, "Simulation and Implimentation of a Hybrid Computer Algorithm for Optimal Nonlinear Filtering," Proc. 9th Symposium on System Science, Honolulu, Hawaii, 1976.

R.S. Bucy, K.D. Senne, H. Youssef, "Pipeline, Parallel and Serial Realizations of Phase Demodulators," to appear Proc. Symposium on Stochastic Control, Marcel Dekker, New York, 1977.

R.S. Bucy, J. Pages, " A Priori Bounds for the Cubic Sensor Problem," to appear.

R.S. Bucy, K. D. Senne, H. Youssef, "Pipeline Software for Filtering," to be submitted IEEE Trans. on Computers.

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The research program consisted of two parts, parallel and pipeline synthesis of nonlinear filters and a priori bounds for the mean square error of nonlinear filters. It was noted very early in the program that the choice of computational realization device could produce dramatic changes in estimate production speed, especially parallel and pipeline devices. Specific programs were tailored to three difference computers to realize the nonlinear filter and take full advantage of the problem's parallel structure for each machine. The speed of → next page.

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20 Abstract

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